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Moisturizers: The Slippery Road

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Abstract

Moisturizers are an important part of a dermatologist's armamentarium although little is written and well, a less is truly known about them. There is a cornucopia of projected skin products in the market whose real scientific role is not proven. These products although at times are regarded as mere cosmetics but have a well-known role in many skin disorders. Adequate knowledge about their mechanism of action, dosage, usage, and adverse effects is must for a dermatologist in this era. This article aims to bring forth the ever hidden facts of the much-hyped moisturizers. It is probably the first of its kind covering all aspects of moisturizers ranging from basic science to clinical usage, a subject that receives a short shrift in the current dermatological text.

Keywords: *Emollients, humectants, moisturizers role in dermatology*

What was known?

- Moisturizers are perhaps the most used therapeutic agents by dermatologists and nondermatologists alike
- They come in varied forms and mostly are neglected in academic discussions.

Introduction

There has been a recent migration in humankind's way of thinking toward a desire for holistic products, especially pertaining to skin care. Moisturizers are perhaps the most prescribed products in dermatology practice and also the most intriguing one. The incidence of dryness related dermatoses are on the increase courtesy urbanization, adulteration, pollution, increased life span, and abandonment of traditional oil

massages and baths. The majority of the human population applies many moisturizers throughout their lifetime; it thus behooves a dermatologist to have a comprehensive knowledge of the same. The term “moisturizer” is a marketing term with little or no scientific meaning. Consumers regard them to increase the water content of the skin while dermatologists consider them as bland oleaginous substances.[1] Dryness is not a single entity but is characterized by differences in chemistry and morphology in the epidermis depending on the internal and external stressors.[2]

History

Curiously, there is no consensus regarding the definition of a moisturizer. The term itself is a neologism coined by the Madison Avenue marketers, promoting the facile idea that they moisten the skin.[3] The desire to apply oily materials to the skin is almost instinctive and may be as old as humankind itself.[2] Traditionally, moisturizers were believed to inhibit the transepidermal water loss (TEWL) by occlusion. Stratum corneum (SC) although a dead layer acts as an active membrane as suggested by the bricks and mortar model. It is the loss of intercellular lipids, i.e., the ceramides, cholesterol, and fatty acids that form the bilayers, damaging the water barrier formation thus leading to dry skin.[3] Dry skin is noted when the moisture content is <10%, and there is a loss of continuity of the SC.[4]

Classification

There are four main types of moisturizers depending on their mechanism of action as shown in [Table 1](#). [2,3,4,5]

Emollients They are mainly lipids and oils, which hydrate and improve the skin softness, flexibility, and smoothness. The skin slip or lubricity contributes to consumer satisfaction.[6] Intracellular lipids comprising multilamellar, which are located between SC play a major role in skin architecture. In SC, ceramides are the major lipid constituents and along with neutral lipids, they form broad laminated intercellular sheets, which act as barriers to our environment.[7] Natural ceramides or the synthetic ones are too expensive. Hence, several pseudo-ceramides are useful as emollients.[3] Lipophilic compounds such as cholesterol and ceramides are being used in topical skin creams. They get easily incorporated into liposomes and make the skin texture softer and smoother. Nanoencapsulated triceramides are also being used for increasing the hydration of the skin.[8] Long chain saturated fatty acids, for example, stearic, linoleic, oleic, and lauric acid and fatty alcohols are essential fatty acids that are found naturally in palm oil, coconut oil, and wool fat. They influence skin physiology and pathology via their effects on skin barrier functions, eicosanoid production, membrane fluidity, and cell signaling.[2] Canola oil in specific is known to reduce sodium lauryl sulfate (SLS) irritation.[4]

Squalene as moisturizer Squalene is one of the most common lipids produced by human skin cells and is a component of human sebum.[9] It is an isoprenoid compound and acts as an intermediate metabolite in the synthesis of cholesterol. In humans, about 60% of dietary squalene is absorbed. It is transported in serum generally in association with very low-density lipoproteins and is distributed ubiquitously in human tissues, with the greatest concentration in the skin. Although squalene is produced naturally by the body, the production of this chemical slows drastically after age thirty, thus contributing to dry skin. It can be derived from both plant and animal sources. It acts as a quencher of singlet oxygen, protecting human skin surface from lipid peroxidation due to exposure to ultraviolet (UV), and other sources of ionizing radiation. Squalane is a saturated form of squalene in which the double bonds have been eliminated by hydrogenation. Squalane is less susceptible to oxidation than squalene. Squalane is thus more commonly used as a moisturizer.[10]

An added boon of squalane is that even though it is technically oil, it does not have an oily feel, is odorless, noncomedonal, antibacterial, and is safe for sensitive skin.[11] Besides its emollient action, it is also used in treating skin disorders such as seborrheic dermatitis, acne, psoriasis, or atopic dermatitis.[12]

Various types of emollients are as shown in [Table 2](#).[\[2,3,4,5\]](#)

Humectants They are basically hygroscopic compounds which mean they attract water from two sources, from the dermis into the epidermis and in humid conditions from the environment. Many humectants have emollient properties as well.[\[2\]](#) Natural moisturizing factor made of a mixture of low molecular weight soluble hygroscopic substances such as lactic acid, pyrrolidone carboxylic acid, and amino acids is a major player for hydration of the SC.[\[2\]](#) [Table 3](#)[\[2,3,4,5\]](#) lists the various humectants available. Trihydroxylated molecule glycerol is the most effective humectant. The mechanism of action[\[13,14,15,16\]](#) is as shown in [Figure 1](#). Urea has been shown to reduce TEWL in atopic and ichthyotic patients[\[17,18\]](#) and reduce SLS-induced skin irritation.[\[19\]](#) It is a humectant at a lower concentration (10%) but in higher concentrations (20–30%) it disrupts the hydrogen bonds of epidermal proteins leading to keratolysis.[\[4\]](#) Alpha hydroxy acids are effective in treating xerosis. Lactic acid particularly the L-isomer stimulates ceramide synthesis leading to higher SC ceramide levels which result in superior lipid barrier and effective resistance against xerosis.[\[5\]](#)

Humectants are a double-edged weapon as they increase TEWL by enhancing water absorption from the dermis into the epidermis where it is easily lost to the environment. It is for this reason that they are mostly combined with occlusive.[\[5\]](#)

Occlusives They are substances that physically block TEWL in the SC. They create a hydrophobic barrier over the skin, contribute to the matrix between corneocytes and have the most pronounced effect when applied to the slightly dampened skin.[\[5\]](#) A wide range of occlusives is available as shown in [Table 4](#).[\[2,3,4,5\]](#) They are basically oils that are thought to diffuse into the intercellular lipid domains thus contributing to their efficacy. Mineral oils are derived from petroleum. The two most important materials are liquid paraffin (also called mineral oil and paraffinum liquidum) and petrolatum, consisting of a complex combination of hydrocarbons. Depending on the distribution of molecular weight, materials with different viscosity are obtained. During the refining process, the hydrocarbon material is hydrogenated to create oxidation resistant molecules throughout from the liquid to the solid waxes. This gives a long shelf life to these products. Among all petroleum jelly is one of the best moisturizers having a water vapor loss resistance 170 times that of olive oil but is cosmetically less acceptable due to its greasiness.[\[20\]](#) Lanolin secreted by sebaceous glands of sheep, is a complex structure of esters, diesters, hydroxyesters of high molecular weight, lanolin alcohols, and lanolin acids.[\[3,21\]](#) Unlike human sebum, it contains no triglycerides.[\[3,22\]](#) Petrolatum in a minimum concentration of 5% reduces TEWL by more than 98% followed by lanolin, mineral oil, and silicones which only reduce TEWL by 20–30%.[\[4,20\]](#) The limiting factors with most occlusives being an odor, potential allergenicity, and the greasy feel.

Role of Moisturizers

1. Moisturizing action[\[23,24,25,26\]](#): This is the most vital action by which they increase the water content of the SC. Hydration smoothes the skin surface by flattening the “valleys” between the skin contour ridges. It also makes the skin surface soft, more extensible, and pliable. The moisturizing action of emollients is evident maximum 30 min–1 h after their use and usually lasts for 4 h.
2. Anti-inflammatory action: Many moisturizers inhibit the production of proinflammatory prostanooids by blocking cyclooxygenase activity thus have a soothing effect on inflamed skin[\[23,24,25,26\]](#)
3. Antimitotic action: Moisturizers containing mineral oils have low-grade antimitotic action on the epidermis and thus are useful in inflammatory dermatosis like psoriasis, where there is increased epidermal mitotic activity[\[23,24,25,26\]](#)
4. Antipruritic action: Emollients downregulate the cytokines thus reducing the itching. Furthermore, cooling effect following evaporation of water from the skin surface after using water based moisturizers has antipruritic effect[\[23,24,25,26\]](#)

5. Photo protective action: These days' sunscreens with variable sun protection factor are incorporated in the moisturizers providing additional sun protection.[23,24,25]
6. Miscellaneous actions[23,24,25,26]:
 - Quality of life improvement: Having a smooth and hydrated skin plays a good role in our social life and psychological satisfaction
 - Antimicrobial action: Act against skin surface microbes
 - Wound healing: Hyaluronic acid is known to play a role.

Dispensing Formulations

Moisturizers are available in different formulations [Table 5] depending on the dispensing medium. The predominant form of delivery is a cosmetic emulsion. The process of emulsification combines various phases containing the active ingredients.[5,23,24]

Depending on the site of application, the moisturizers are generally marketed in various categories. Within each category, there are specialized products geared for certain areas such as lips, under eyes, feet. Commercially, they are classified as:

1. Facial moisturizers[5,27,28]: Face in particular is prone to effects of environment such as cold and hot weather, arid conditions, humidity, dust, pollution, and UV rays. Hence, facial moisturizers have a unique place in daily skin care. They are designed to be nongreasy, noncomedogenic with an emphasis on esthetics and maximal skin benefits. Silicone-based derivatives are suitable for oily skin. Other ingredients are added to reduce the appearance of excess shine such as oil absorbent compounds, for example, kaolin, talc.[5] Under eye creams are lightweight cream formulas meant to restore firmness, diminish dry lines, reduce puffiness, and pigmentation. Essentially, they are moisturizers, and their effects are limited to those of other routine moisturizers.
2. Body and hand feet moisturizers: They are mostly aimed at prevention as well as treatment of dry skin, eczema, and xerosis. They are dispensed in the form of lotions, creams, and mousse. Some specialized products aims include cellulite firming, bronzing, and minimizing the signs of aging.[5]
3. Anti-aging products: The quest for a younger looking skin has led to a boost in the anti-aging technology. Special agents are especially useful for photoaged skin and include sun protectants, alpha hydroxyl acids (e.g., glycolic acid), retinol, and its derivatives. These moisturizers play a role in treating and augmenting therapy for the aging face.[27,28]

Where to Use?

Moisturizers have a wide array of usage and benefits for many dermatological conditions which have a common underlying effect of dryness. The dry skin disorders are induced by complex interactions between environmental and individual factors. Various factors contributing are low environmental temperature,[29] low humidity,[30] exposure to chemicals,[31] microorganisms,[32] aging and psychological stress,[22,33] atopic dermatitis, and eczemas.[34,35,36,37] Table 6[1,2,3,4,5] (although not exhaustive) lists the common indications for use of moisturizers.

Xerotic skin The appearance of the skin is essential for an individual, and a flawed presentation often results in reduced self-esteem by self and others.[38] The impression of dryness is formed by inherent sensory components in skin along with visible and tactile changes of the surface. A feeling of dryness, an uncomfortable skin that is, tight, painful, itchy, stings, and tingles are the symptoms of dry skin [Figure 2]. [38,39] Application of moisturizers leads to increase in water content in the SC,[40] and a smoothing of the surface can be observed, as a result of the filling of spaces between partially desquamated skin flakes.

[41,42] Thereafter, skin mechanics change[43] and the increased hydration will facilitate degradation of desmosomes keeping the corneocytes together.[44,45] A possible strengthening of a weakened skin barrier function may also occur, which can make skin less susceptible to attacks from noxious substances and prevent the development of eczema.[17,46,47] This may explain why moisturizers are a useful adjunct in the treatment of inflammatory dermatoses as steroid-sparing therapy.[48]

Dosages and methods of application Finding the most suitable moisturizer for an individual may be a matter of trial and error. The right time and the right way to apply the moisturizers hold the key to maximum benefits. Except for humectants and hydrophilic matrices which can absorb water from atmosphere or underlying skin layers the more commonly used occlusive oils should be applied on moist skin.[2,3] The skin should be moistened as after dabbing it following a bath or by rubbing a wet cloth (sponge bath). After rubbing the moisturizer in both palms, it should be lightly applied along the direction of the hair follicles. To prevent the well-known adverse effect of oil folliculitis because of vigorous rubbing, the method of application should be repeatedly explained to the applicant.

As for other actives, the efficacy of moisturizers is likely to depend on dosage where compliance is a great challenge. It is often difficult to estimate the amount applied making it difficult to compare the effectiveness of moisturizers and may also cause doubts about the compliance. Intensive education from a dermatology nurse has resulted in 800% increase in the use of moisturizers (426 g weekly of emollient cream/ointment) and no overall increase in steroids accounting for potency and quantity used.[49] There is difference in dosing in self and assisted application of creams. Self-application resulted in larger amount applied per unit area.[50,51] Furthermore, distribution of the moisturizer depends on the vehicle used.[52] A thick ointment (with a few percent of water) is more evenly distributed whereas the formulations with lower viscosity and more volatile ingredients were less evenly spread on the skin.[52] Furthermore, dispensing jars promoted more consumption of larger quantities than same in a tube (1.7 vs. 0.7 mg/cm², respectively).[51] Once applied to the skin, the ingredients can stay on the surface, be absorbed into the skin, metabolized or disappear from the body by evaporation, and sloughing off or by contact with other materials. Only 50% of applied creams were found to remain on the surface after 8 h.[53] Transfer of the actives to the surrounding surfaces is easier for creams and ointments than lotions and tinctures.[54] Depending on the severity of xerosis, the frequency of application can vary between 1 and 3 times daily, especially after bath.

Special Additives in Moisturizers

1. Botanical substances: In this era of going natural, the use of herbal products and extracts has caught everyone's attention. These herbal products are being used in topical preparations since time immemorial. However, the rationale to include herbal extracts in moisturizers has not always been based on controlled studies or evidence-based meta-analysis of clinical trials.[55] Instead, they may be added for marketing reasons to nurture consumer interest in the perceived benefits of natural ingredients on the skin

- The most famous of all is *Aloe* (*Aloe barbadensis* Miller leaf extract), of which more than 300 species are available. Evidence to support its role as a moisturizer is lacking although its role in healing of skin ulcers and burns due to its anti-inflammatory, antibacterial, and vasodilator action has been propounded from time to time[56]
- Allantoin (comfrey root) is a synthetic derivative known as aluminum dihydroxy allantoinate. It has been marketed for its role as moisturizer as well as keratolytic. However, supportive studies are lacking[57]
- Oatmeal (*Avena sativa*) baths for soothing rashes have been part of nursing practice since decades and are considered to be highly relieving to the patient[55]

- Bioflavonoids, i.e., plant derived polyphenols are being promoted as topical antioxidants. As a result, they have found a suitable place as an additive to the moisturizers. However, how far they are useful in relieving the oxidant stress of the skin is yet to be proved.[57]
2. Antioxidants[58]: Are the agents which inhibit oxidation of ingredients by reacting with free radicals and blocking the chain reaction. Typical antioxidants are tocopherols (Vitamin E), butylated hydroxytoluene, and alkyl gallates.[20] Reducing agents, such as ascorbic acid, may also act by reacting with free radicals, as well as oxidize more readily than the ingredients they are intended to protect[20]
 3. Chelating agents[58]: Citric acid, tartaric acid ethylenediaminetetraacetic acid, and its salts have limited antioxidant activity themselves, but enhance the efficacy of antioxidants by reacting with heavy metal ions. Such substance is called chelating agents.
 4. Vitamins[22,23]: There have been poorly substantiated claims of skin rejuvenation by the addition of Vitamins such as A, C, and E. However, their penetration through the skin is doubtful. They should be in water soluble form to be absorbed percutaneously hence oral/parenteral supplementation is preferred over topical application of the same.
 5. Fragrances and coloring agents[22,23]: Added more for their cosmetic enhancement rather than any actual role as moisturizers. They may vary from cinnamic acid, cinnamates, menthol, benzoin resin, etc. Coloring agents impart subtle hues and other optical effects leading to more acceptance although at times can lead to irritant dermatitis.
 6. Preservatives[58]: They are meant to kill or inhibit the growth of microorganisms inadvertently introduced during use or manufacturing. Contaminating organisms may be either pathogens or nonpathogens. The ideal preservative must have a broad spectrum of activity; it must be safe to use; it should be stable in the product, and it should not affect the physical properties of the product. No single preservative meets all these requirements, and usually a combination of substances is used. Phenoxyethanol and parabens (methyl-, propyl-, ethyl- and butyl-paraben) are the most frequently used in moisturizers.
 7. Emulsifying agents[22,23]: The natural tendency of any oil and water to separate in different phases is undone by the addition of emulsifying agents mostly detergents. The most commonly used ones are Laureth 4 and 9, ethylene glycol monostearate, octoxinols, and nonoxinols. Liposomes dispersion is the newer technique which delivers the active ingredients into the epidermis for enhanced action.
 8. Sunscreens[22,23,25]: Last but not the least, they have found a comfortable berth as an important ingredient in many moisturizers serving a dual function, for example, replenishing creams. Cinnamates, titanium dioxide, and zinc oxide have replaced the much toxic para-aminobenzoic acid agents.

Adverse Effects

As compared to various topical drugs used by dermatologists, moisturizers are rarely associated with health hazards, although they may be used on large body surface areas over a major part of the life span. Various forms of skin discomfort from topical preparations are more common encountered, as virtually any substance can cause skin reactions in sensitive areas in some individuals. Atopics are particularly at risk for adverse skin reactions because of the impaired barrier function. Facial skin is also more sensitive than other body regions[59,60] possibly the result of a less efficient barrier with a smaller number of SC cell layers and the presence of large follicular pores.[61]

Skin irritation[2,62]

It is the most common adverse effect of moisturizers, can be visible and invisible. They are basically sensory reactions or subjective sensations with/without signs and symptoms of inflammation. Common presenting complaints are in the form of smarting, tingling, and stinging sensations. Based on the skin response, it is classified into four mechanisms:[62]

- Sensory/subjective irritation
- Allergic contact dermatitis
- Nonimmunologic contact urticaria
- Irritant contact dermatitis.

[Table 7](#) provides a plausible list of adverse effects encountered with moisturizers. By keeping them in mind, an astute clinician can change or select the appropriate moisturizer preventing much discomfort.

The Indian perspective Moisturizers have found a comfortable seat in the Indian market, and are used widely and variedly. Although there is paucity of Indian literature, few reports on usage of moisturizers in some specific dermatoses do throw some light.[78,79] The exact knowhow's of their usage pertaining to Indian skin is still lacking. Mostly Indian skin types are of Fitzpatrick type IV–V though a wide variability does exist.[80] Saying this does implement that moisturizers can be used solely with little additives like sun blocking agents. Variability of skin type depending on dry, oily, combination or normal skin does guide the amount, frequency, and type of moisturizers like in any other ethnicity as discussed earlier.

Ideal moisturizer[2,4,5] The search for an ideal moisturizer is a vain task, for the needs and results are highly subjective. However, an ideal moisturizer should have some attributes which make them suitable in most of the conditions and for most of the applicants.

An Ideal Moisturizer Should

- Reduce and prevent further TEWL
- Restore lipid barrier, i.e., duplicating and enhancing the skin's moisturizing retention mechanisms
- Hypoallergenic, nonsensitizing, fragrance free, noncomedogenic
- Absorbed immediately, providing immediate hydration
- Cosmetically acceptable
- Affordable.

Conclusion

Till date choosing, the right moisturizer is still a matter of trial and error. As the population ages and we turn into an urbanized makeover worldwide, the need of moisturizers will be ever increasing. The key to future moisturizer therapy will be to tailor specific agents to specific dermatological needs. This review helps provide a fundamental understanding of the physiochemical and psychological effects of the use of moisturizers. Knowing the in and out of the actives and their interactions with the skin will help better usage and efficacy of the available moisturizers. This voluminous text is an attempt to provide wholesome knowledge to diverse players of skin care: dermatologists and physicians; dermatological scientists who involve in skin biology, academicians.

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What is new?

- The typology, dispensing formulations, and role of moisturizers are widely discussed, with an attempt to provide wholesome knowledge
- Apt information about usage and adverse effects will make their role more beneficial.

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Figures and Tables

Table 1

The various classes of moisturizers

Class	Emollients	Humectants	Occlusives	Protein rejuvenators
Mechanism of action	Saturated and unsaturated variable length hydrocarbons which help in skin barrier function, membrane fluidity and cell signaling leading to overall improvement in skin texture and appearance. Often used in combination with emulsifiers	Mostly low molecular weight substances with water attracting properties into the stratum corneum. Used along with other components to retain the water content	Oils and waxes which form an inert layer on the skin and physically block transepidermal water loss	Small molecular weight proteins thought to help is skin rejuvenation by replenishing essential proteins
Indication	Skin dryness, roughness, papulosquamous disorders, and routine skin care	Xerosis, ichthyosis	Xerosis, atopic dermatitis, prevention of contact dermatitis	Skin rejuvenation, aging, photodamaged skin
Adverse effects	Rarely contact irritant	Irritation (urea, lactic acid)	Messy to apply, cosmetically unacceptable. Folliculitis (mineral oil), acneiform eruptions, contact dermatitis (lanolin)	Contact dermatitis
Examples	Cholesterol, squalene, fatty acids, fatty alcohols, pseudoceramides	Glycerol, propylene glycol, panthenol sorbitol, urea, alpha hydroxy acids, hyaluronic acid	Petrolatum, beeswax mineral oil, silicones, lanolin, zinc oxide	Collagen, elastin, keratin

Table 2

Classification of emollients

Table 3

The various humectants

Figure 1

The mechanism of action of glycerol

Table 4

Various classes of occlusives

Table 5

Various dispensing formulations

Table 6

Uses of moisturizers

Figure 2

Various characteristics of dry skin

Table 7

Adverse effects of moisturizers

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